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The Soviet Candid Tanker Aircraft



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An Intelligence Assessment

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The Soviet Candid Tanker Aircraft



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An Intelligence Assessment

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This paper was prepared by [redacted] of the
Office of Scientific and Weapons Research.

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Contributions were made by [redacted]

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Summary

*Information available
as of 1 December 1983
was used in this report.*

[redacted] indicate that the Soviets are developing a new tanker aircraft based on the IL-76 Candid long-range transport. The Candid tanker's refueling equipment is carried in pods similar to Western hose-drogue refueling pods. These pods will enable it to refuel two fighter-size aircraft simultaneously. The Soviets probably will preserve the transport capability of the tanker so a single aircraft can function in either role without modifications. [redacted]

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A comparison with the two current Soviet tankers indicates that the radius-payload performance of the Candid tanker is slightly inferior to that of the Bison tanker but is far superior to that of the Badger tanker, which makes up about three-fourths of the Soviet tanker fleet. At a radius of 1,000 nautical miles, the transferrable fuel payload of the Candid tanker will be over three times that of the Badger tanker or 80 percent that of the Bison tanker. Aircraft range/radius increases from aerial refueling can vary significantly depending on the receiver's mission profile. Range/radius increases of almost 50 percent are not unusual. [redacted]

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The overall development of the Candid tanker has been relatively slow, probably because the Soviets did not need the new tanker urgently and not because of technical problems. [redacted]

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[redacted] The Candid tanker could be operational as early as 1984. It will supplement and eventually replace the aging fleet of Bison and Badger tankers, which have been out of production for over 20 years. The new Candid probably will provide tanker support to 2010 or beyond. [redacted]

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The Soviet Candid Tanker Aircraft

Introduction

The Candid transport was designed by the Ilyushin design bureau in the late 1960s and became operational in 1974. The basic transport version is designated IL-76 or IL-76T by the Soviets, Candid A by NATO. The IL-76M (Candid B), the armed version of the basic transport, has a self-protective electronic countermeasures (ECM) suite and carries two 23-mm guns and a fire-control radar in a tail turret.

The Soviet Air Force now uses modified Bison and Badger bombers as tankers, and the Navy uses Badger tankers. The Soviets have approximately 30 Bison tankers and 100 Badger tankers. Soviet medium and heavy bombers and Moss and Mainstay airborne warning and control system (AWACS) aircraft are equipped as receivers. Medium and heavy bomber derivatives, such as the Bear D maritime reconnaissance aircraft and the Bear F antisubmarine warfare (ASW) aircraft, are also equipped as receivers.

The Soviets use two inflight refueling techniques. All Soviet receiver aircraft except Badger are equipped with refueling probes for hose-drogue refueling, during which the tanker first extends the refueling hose and drogue. The receiver aircraft then maneuvers to place its probe within the tanker's drogue. When contact is made, the probe-drogue coupling engages and fuel is transferred to the receiver through the hose. Some Badger tankers use a wingtip-to-wingtip variant of the hose-and-drogue method. This is compatible only with Badger receivers.

The Candid Tanker

The only major difference between the transport and tanker versions of the Candid probably will be the addition of refueling-related equipment. The cargo-handling equipment probably will be retained so that the aircraft also can function in a transport role.

the new tanker uses the Candid B airframe. Candid tankers probably will not have the tail guns and radar of the Candid B; if so, the tail-gun position could be used as a station for an observer or a refueling systems operator.

Bison and a few Badger tankers carry probe-drogue refueling equipment internally and extend the hose through their bomb bay doors. In contrast, the Candid's refueling system is carried in external pods. These pods are probably designed to use a hose-reel system for probe-drogue refueling. The conventional hose-reel refueling pod contains the following components:

- The refueling hose, used to transfer fuel to the receiver.
- A stabilizing drogue, which serves as the target for the receiver aircraft's refueling probe and is attached to the free end of the hose.
- The hose-reel assembly, which extends and retracts the refueling hose and maintains proper hose tension throughout the refueling operation.
- The hose guillotine, used to sever the hose if the extended hose must be jettisoned.
- A fuel-pressure regulator, which prevents the fuel pressure from exceeding the maximum allowable pressure at the probe-drogue coupling.
- Inert-gas surge suppressors, which prevent damage to other system components by absorbing pressure surges in the fuel system.

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Technology Transfer**Candid**

The design of the IL-76 Candid is much like the design of the US C-141. Soviet aircraft designers have long copied Western aircraft designs successfully. The degree of imitation has ranged from borrowing incidental design details of subsystems to copying the entire aircraft, piece by piece. [redacted]

[redacted] the Ilyushin design bureau (OKB) greatly admires Lockheed Aircraft designs, and copied the Lockheed C-141 as much as possible in the Candid. [redacted]

In the C-141 the Ilyushin OKB found an aircraft with about the right size and performance to satisfy Soviet requirements for a military transport and Siberian service aircraft. In early 1964, soon after the first flight of the C-141, the Ilyushin OKB acquired several C-141 drawings and photographs that appeared in Western open-source publications. Ilyushin engineers liked the general configuration and many design details such as the aft cargo door with integral loading ramp. They decided to retain as many of these features as possible in the new Ilyushin design. [redacted]

In designing the Candid, Ilyushin engineers kept the C-141 wing and engine configuration, tail geometry, and integral loading ramp. Ilyushin also copied the engine pylon design of the C-141, a process that was made easier when Ilyushin engineers got a firsthand look at a C-141 accompanying a US presidential delegation to Moscow in 1967. In addition, the Soviets thoroughly studied the C-141 at two Paris Air Shows, where they photographed and measured the C-141 and took metal samples. [redacted]

Although Ilyushin copied many features of the C-141, the Candid and the C-141 are not identical. Ilyushin modified the C-141 design to meet Soviet

requirements—a common Soviet practice. The Candid was designed with a wider fuselage and heavier maximum takeoff weight. Technology transfer probably was limited to copying general design concepts rather than using the specific technology developed in the C-141 program. [redacted]

Refueling Equipment

Soviet representatives at the 1975 Paris Air Show were very interested in a hose-drogue aerial refueling pod manufactured and exhibited by a British firm. The Soviets asked many technical questions and requested detailed specifications about the equipment. The Soviets also inquired about the firm's ability to deliver probe-and-drogue aerial refueling equipment to the USSR. [redacted]

During the 1977 Paris Air Show, members of the Soviet delegation made daily visits to a display of an aerial refueling system made by a US manufacturer. The Soviets requested information on ordering the equipment, but they were told that it would be necessary to obtain clearances for the equipment from the US Department of State. One engineer in the Soviet delegation commented that the Soviets had had difficulty developing an aerial refueling capability. He said that, as a result, the Soviets were attempting to acquire refueling equipment from a non-Bloc country. [redacted]

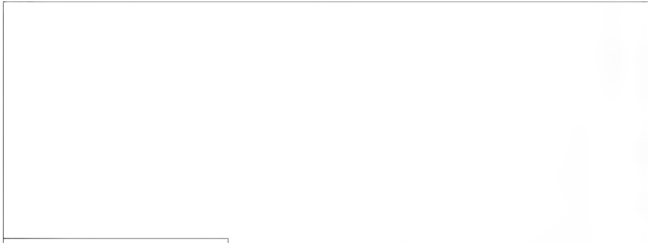
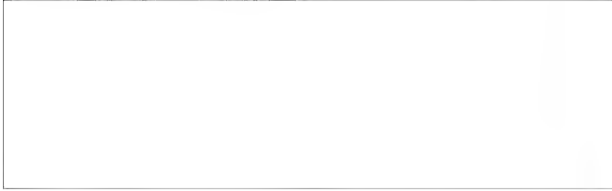
We do not know if the Soviets actually acquired (legally or illegally) hose-drogue refueling hardware from Western sources, or if the Soviet hose-drogue refueling pod is based on a Western design. In any case, it is likely that the Soviets benefited from Western technology acquired from open sources. [redacted]

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Development and Testing

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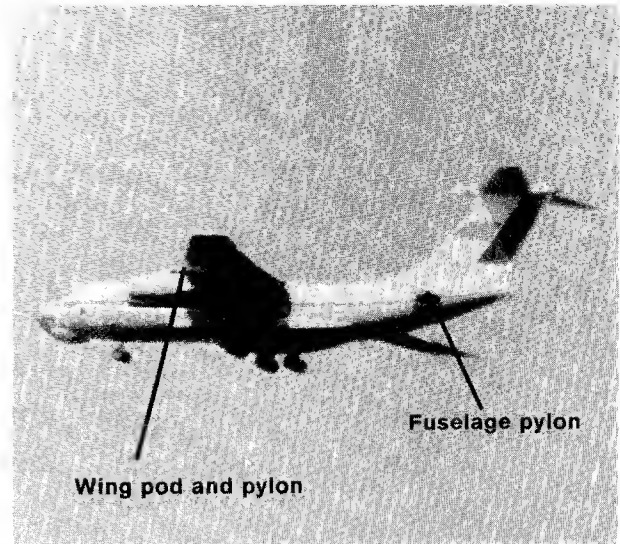
Ground photography dated July 1982 shows that the tail guns had been removed from the aircraft (figure 1).

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¹ The Bort number is the identification number painted on the aircraft's wing and tail.



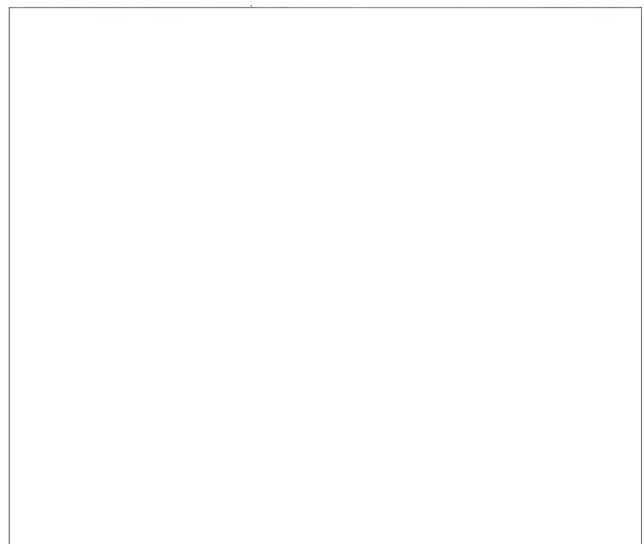
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Figure 1. Candid 76501.

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The new phase in flight-testing probably marked an attempt to meet certain flight test objectives before the tanker entered production. A Candid that was probably the first preseries production tanker was

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. This aircraft, Bort No. 76556, is a Candid

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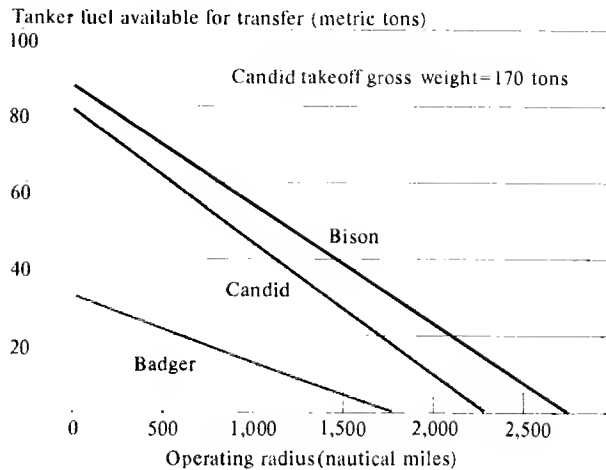
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B with a configuration like that of 76501.

Figure 2
**Comparison of Tanker Radius-
 Payload Performance**



Candid mission rules *

- Five minutes at military power at sea level for warmup, taxi, and takeoff.
- Climb to initial cruise altitude.
- Cruise climb for best range to refueling point.
- Transfer fuel to receiver(s)—no fuel consumed and no distance credited.
- Cruise climb for best range to base.
- Descend and land.
- Fuel reserves of 7 percent of initial fuel (excluding fuel payload) required upon landing.

* The mission rules for the Bison and Badger are similar but not identical. Bison and Badger performance is included for rough comparison only.

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addition of supplementary fuel lines and pumps, and the removal of tail guns and gun radar.

The estimated weight of each refueling pod is about 350 kilograms (kg), as shown in the following tabulation:

Reel and hose	170
Fuel plumbing	30
Pod and pylon structure, hydraulics, and electrical equipment	150

Aircraft Analysis

Radius-Payload Performance. Our analysis shows that the radius-payload performance of the Candid tanker is far superior to that of the Badger tanker and somewhat inferior to that of the Bison tanker. At a radius of 1,000 nautical miles (nm), the Candid can supply more than three times as much fuel to receivers as the Badger. At the same radius, the Candid's transferable fuel is about 20 percent less than that of the Bison. The assessed radius-payload performance of these tankers is given in figure 2.

Our analysis of the Candid tanker is based on mensuration of the Candid 76501 fuselage pod and assumes that the wing pods are identical. The fuselage pod is about 5 meters long and about 0.8 meter ² in diameter (figure 3).

Fuel Capacity. Our analysis indicates that the Candid tanker has 84 metric tons of fuel available at takeoff. This amount is the difference between the tanker's takeoff gross weight (TOGW) and the operating weight empty (OWE).

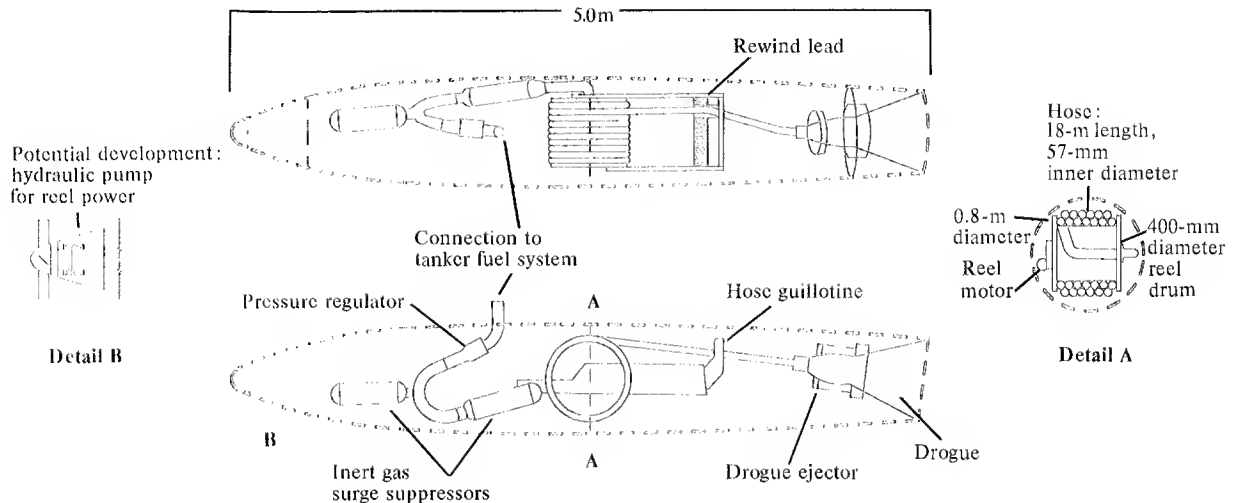
We estimated the tanker's OWE at about 86 metric tons. This estimate was obtained by modifying the transport OWE.³ We assumed that the Candid tanker would retain all transport-related equipment such as winches and loading ramps. Our estimate accounted for the installation of refueling pods and pylons, the

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Figure 3
Possible Equipment Arrangement for Candid
Refueling Pod



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We included an additional weight penalty of about 160 kg in the tanker for additional fuel lines and pumps to augment the parent fuel system for support of the three refueling pods. Thus, the total weight for the three pods and additional fuel systems is about 1,200 kg. Removing the gun system (about 1,000 kg) and adding the refueling system (1,200 kg) yields a net increase of 200 kg to the transport OWE. []

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The maximum takeoff gross weight (TOGW) of the tanker is probably the same as the maximum TOGW of the Candid B transport—170 metric tons. Increasing the tanker maximum TOGW to more than 170 metric tons would require either significant structural modifications to the aircraft or a reduction in the allowable load factors. Because a weight increase is not necessary to accomplish the tanker mission, we do

not believe the Soviets will modify Candid B airframes to increase the maximum TOGW. We do not believe the Soviets will operate the aircraft at an overload gross weight by reducing the maximum allowed load factors because it is not a typical Soviet practice. []

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Fuel-Flow Rate. Our estimate of fuel-flow rate is 1,130 liters per minute. This rate is based on US aerial refueling specifications and is comparable to that of Western hose-drogue refueling pods. The rate at which fuel can be transferred depends on the delivery pressure and hose diameter. Our analysis assumes a delivery pressure of 345 kilopascals (50 pounds per square inch) with a fuel density of 0.81 kg

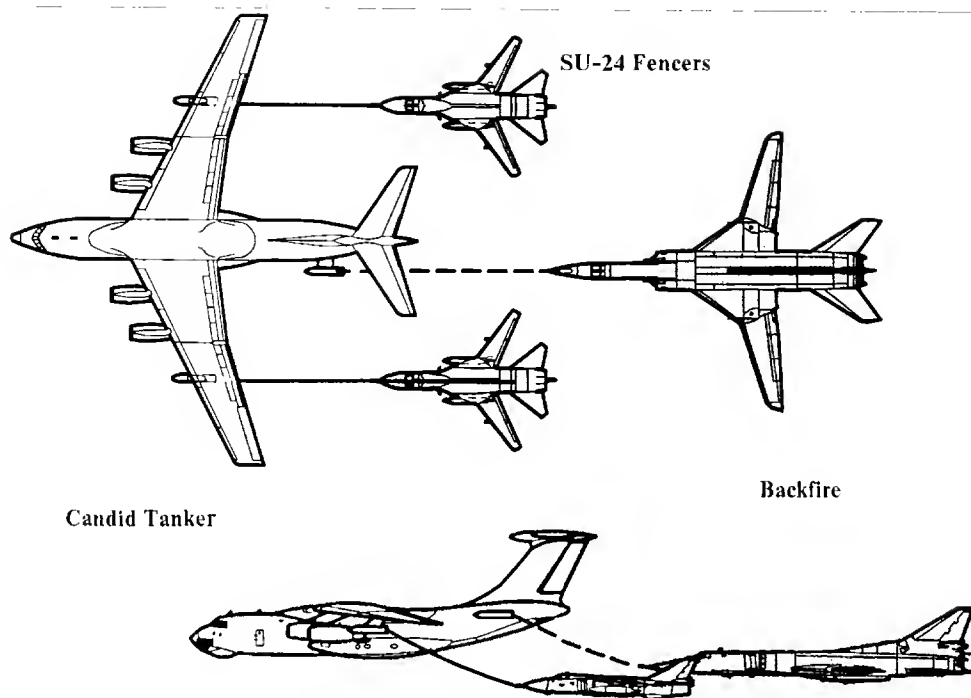
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Figure 4
Candid 76501 Refueling Stations



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per liter. This delivery pressure is comparable to that of Western equipment. [REDACTED]

The hose dimensions are determined by the pod size, fuel transfer rate requirements, and the tanker-receiver separation distance requirements. Soviet tanker-receiver separation requirements are probably comparable to US specifications, and we believe that a hose length of 18 meters will meet or exceed clearance requirements for the Candid. With an 18-meter hose and a pod diameter of 0.8 meter, the outside diameter of the hose will be about 70 mm, based on US specifications. Our estimate of the inside diameter is about 57 mm. [REDACTED]

Refueling Stations. We believe the three refueling stations of the 76501 tanker configuration cannot be used simultaneously (figure 4). The clearance between

receivers using the fuselage pod and the port wing pod is about 4 meters for Fencer with wings at mid-sweep and 6 meters for Fulcrum-size aircraft. Because these clearances seem marginal at best, we believe only the two wing stations will be used simultaneously by fighter-size receivers. Larger aircraft, such as bombers and transports, will have to refuel singly. [REDACTED]

The Soviets might optimize the fuselage-mounted pod for large receivers. Use of the fuselage station would reduce the chance of collision between the tanker and a large receiver. Because the receiver-tanker geometry for the fuselage station permits a slightly shorter refueling hose, the fuselage pod may have a shorter hose of larger diameter than the wing pods. A larger

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diameter would allow a higher fuel-flow rate. Large receivers also may require a different probe-drogue coupling than fighter-size receivers. In this case, the probe-drogue coupling for fighter-size receivers would be carried by the tanker's wing pods only. [REDACTED]

Military Impact

The Candid tanker can add significantly to Soviet capabilities by allowing an increase in the number and type of aircraft capable of receiving fuel from a tanker. [REDACTED]

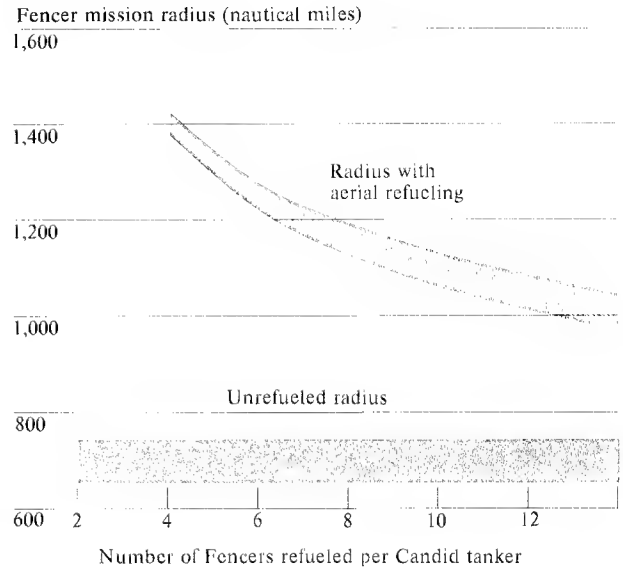
[REDACTED] the existing Bison and Badger tankers can continue their mission into the late 1980s and probably into the early 1990s, if necessary. Because the Bison and Badger tankers are serviceable, they probably will remain in service alongside the Candid tankers for several years before being replaced gradually by Candid tankers. [REDACTED]

Because the Soviets have completed the first preseries production tanker, we believe the Candid tanker could reach initial operational capability as early as 1984 if the Soviets push forward at a reasonable pace. Candid tankers probably will remain in production until at least 1990, and they probably will remain in service until 2010 or later. [REDACTED]

New Receiver Aircraft. [REDACTED]

We expect the Candid tanker will be capable of refueling most Soviet aircraft that currently receive aerial refueling—medium and heavy bombers, their

Figure 5
Optimal Fencer Radius Increases With Refueling



Fencer Mission Rules

- Hi-lo-lo-hi mission, NATO fuel reserves.
- Each lo segment is 50 nm at sea level.
- Five-minute combat fuel allowance.
- Bombload: two 450-kg special weapons.
- Two 3,000-liter external fuel tanks (not dropped).

Note: Shaded regions represent radius uncertainty because of uncertainty in Fencer internal fuel weight.

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derivatives, and Moss and Mainstay AWACS aircraft. The Soviets probably will not adapt the Candid tanker for use with Badger receivers because Badger tankers probably will remain in service as long as Badger bombers are operational. [REDACTED]

Mission Radius Increases. Figure 5 shows the optimal increase in mission radius resulting from pres-trike Candid refueling of Fencer light bombers. The

increase in operational radius is highly dependent on the mission profile, and figure 5 also gives the mission rules used for this example. The increase in Fencer combat radius is significant even when each tanker refuels several Fencer. For example, a Candid tanker refueling six Fencer could result in optimal mission radius increases of 75 to 85 percent for each Fencer. The refueled Fencer performance figures are for optimum conditions and do not account for operational constraints such as minimizing the threat to the tanker from enemy aircraft and surface-to-air missiles.

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For most missions, we expect the receiver to refuel before expending more than 45 percent of its takeoff fuel. (This practice ensures sufficient fuel for the aircraft to return to its point of origin if it cannot be refueled as planned.) Thus, radius increases of up to about 45 percent can be expected with one aerial refueling for a constant-altitude mission profile with no allowances for dash speed or combat.

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Although figure 5 illustrates a combat mission, aerial refueling applies equally well to deployment and supply of distant forces. This would include long-range staging of aircraft as well as materiel transport. Likewise, aerial refueling can be used to significantly extend the loiter time of Moss and Mainstay AWACS aircraft and other special-mission aircraft with a long endurance requirement.

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